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## AN APPARATUS FOR DETERMINING THE TENDERNESS OF CERTAIN CANNED FRUITS AND VEGETABLES

By VICTOR B. BONNEY, *Associate Chemist*, PAUL A. CLIFFORD, *Assistant Chemist*,  
and HENRY A. LEPPER, *Chemist*, *Division of Food Control, Food and Drug*  
*Administration*

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### INTRODUCTION

Tenderness and texture of canned foods are of major significance in the commercial grading of these products. In the enforcement of the provisions of the McNary-Mapes amendment to the Federal food and drugs act, it is important that, for the measurement of these quality factors, there be some device which will be an impersonal and accurate substitute for the teeth and tongue of the expert grader.

In designing a suitable apparatus, fundamental technical and structural considerations had to be kept in mind. The estimation of tenderness necessitates that the work done upon a specific unit be accurately measured. This means that a rigidly standardized rate of applying pressure must be employed. The pressure must be applied in a definite direction to a standardized and firmly supported test piece. The yield point of the test piece must be clearly defined, and the pressure required to produce the specified effect must be capable of precise measurement. After a series of studies on representative samples of canned fruits and vegetables, the Food and Drug Administration has devised an apparatus which, it is believed, meets these exacting requirements and, at the same time, is rugged in construction and sufficiently simple in design to enable the average skilled mechanic to construct it out of relatively inexpensive materials. Application has been filed with the United States Patent Office for a public-service patent on the device which will permit any individual to construct it for his own use.

This apparatus already has proved itself of considerable value in measuring the relative tenderness of canned peas, canned peaches, and canned pears. It may be safely asserted that it will also be applicable to canned fruits of texture similar to peaches and pears,

and, it is hoped, to canned vegetables other than peas. Whether it can be adapted successfully to raw foods and to such classes of canned food as fish, crustaceans, poultry, and the like remains to be seen.

Repeated tests have demonstrated that this device reflects the consensus of opinion of expert graders on canned peas, at or near the border line between the present commercial concepts of what constitutes a standard and a substandard canned pea, so far as tenderness is concerned. The results of one series of tests of this kind were presented at the twenty-fourth annual convention of the National Canners Association, January, 1931.<sup>1</sup>

#### DESCRIPTION OF APPARATUS

The device may be used for measuring the force necessary to compress or crush the test piece to a specified fraction of its original diameter or to penetrate completely the test piece with a standard cylindrical rod. The former method is employed on peas; the latter on peaches and pears.

The essential part of the apparatus, when assembled for testing the resistance of a canned food to crushing, consists of a metal plunger (fig. 1, *a*), one-fourth inch in diameter, sliding freely in a closely fitting sleeve. The plunger has a metal disk, about 2 inches in diameter, attached to its upper end for use as a table or platform for holding weights. The lower end of the plunger terminates in a removable, polished metal disk (fig. 1, *b*) about  $1\frac{1}{4}$  inches in diameter, for crushing the test piece. The test piece is mounted on a removable plate-glass slide resting on a rigid table under the plunger.

Weight is added, in the form of mercury<sup>2</sup> from a mercury reservoir to a suitable<sup>3</sup> flask, standing on the top platform of the plunger, at a constant rate of 12 grams per second. As the mercury drains from the reservoir, additional mercury is added, at an identical rate, from a supplementary reservoir above, so as to maintain a constant effective head of mercury in the lower reservoir. Thus the mercury drains out at a uniform rate when the two stopcocks are properly operated.

When the tenderness of a food is to be tested by crushing, it must be to some predetermined fraction of its original thickness, in order to make a definite end point. Some means must therefore be provided whereby this thickness, before and after crushing, may be measured. These measurements are conveniently made by means of a pivoted lever (fig. 1, *c*), and a curved, graduated scale (fig. 1, *d*). The short arm of the lever terminates in a sensitive contact point (fig. 1, *e*) so insulated from the plunger mechanism that an electric buzzer sounds only when the point is made to touch the lower surface of the plunger platform. The lever is pivoted firmly enough by means of a set screw (fig. 1, *f*) to remain fixed in any

<sup>1</sup> LEPPER, H. A., and BONNEY, V. B. THE STANDARDIZATION OF CANNED PEAS UNDER THE CANNERS' AMENDMENT TO THE FEDERAL FOOD AND DRUGS ACT. Canning Trade 53 (26): 92-96. 1931.

See also Canner 72 (10, pt. 2): 124. 1931.

<sup>2</sup> The Food and Drug Administration uses mercury in its determinations. Dilute nitric acid (1 per cent) is used above the mercury to prevent the accumulation of oxide. Other convenient substances, such as shot or water, could be used.

<sup>3</sup> Of such a weight as to make the total weight of flask and plunger 100 grams.

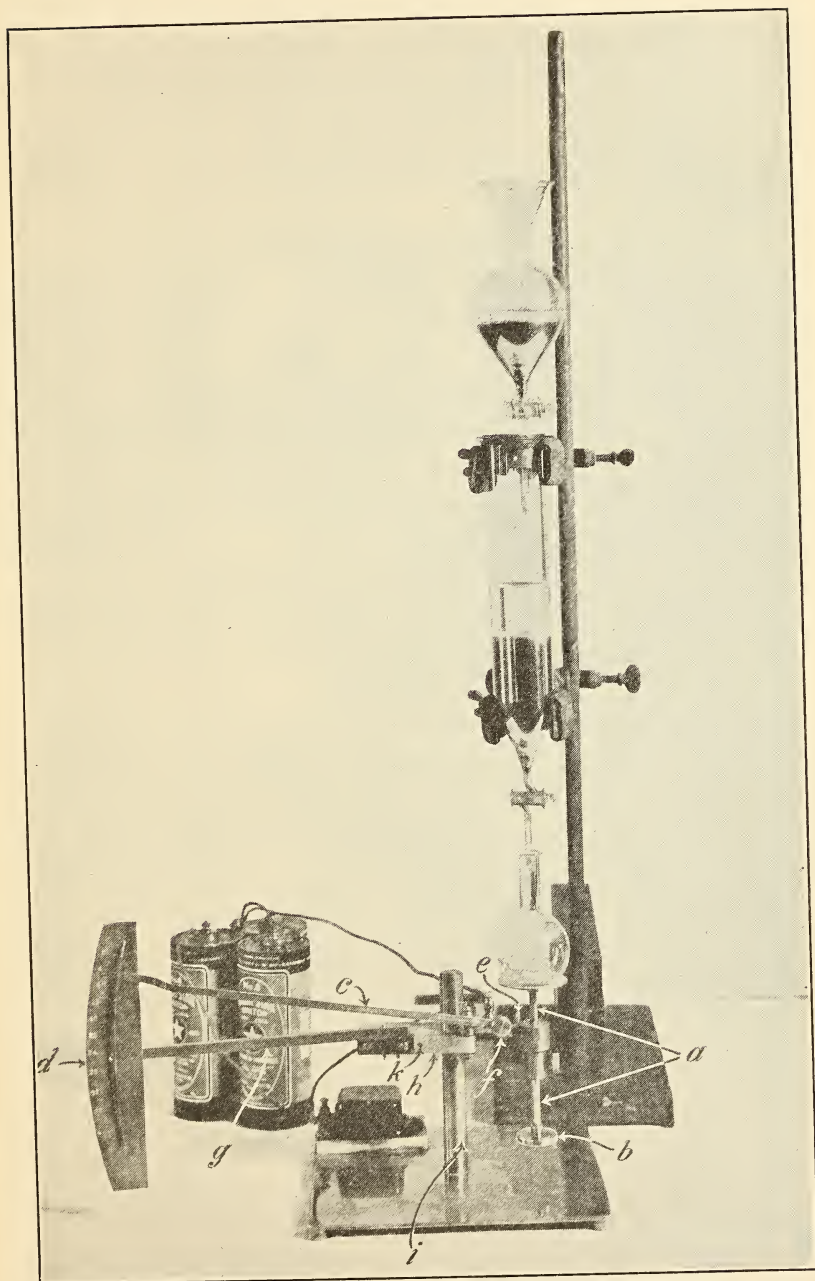


FIGURE 1.—Apparatus for determining tenderness of canned food by crushing



position in which it is placed. With gentle pressure by the hand the long arm can be made to slide along the scale. The short and long arms of the lever are in such relationship one to the other that a vertical depression of the plunger, amounting to one-quarter of an inch, causes the end of the long arm of the lever to move through an arc of about 6 inches along the face of the scale. The long arm of the lever terminates in a chisel end, ruled with a fine line in such a manner that it can be brought close to and in exact alignment with the graduations on the scale, thus permitting accurate readings.

#### CALIBRATION OF SCALE

The zero point on the scale is determined by bringing the bottom of the plunger disk into intimate contact with the glass slide and adjusting the lever so that the short arm just makes contact with the platform. By setting the lever in a similar manner, with a piece of sheet metal having a uniform thickness of about 0.025 inch between the glass slide and lower disk of the plunger, a major division of the dial is marked off. Each succeeding major division is established by the introduction of like pieces of metal of identical thickness, one upon the other, between the glass slide and the disk. The major divisions are numbered in multiples of four, and divided by ruling into four equal units. Each unit is then further subdivided into four equal parts. The subdivisions of each unit will then be about one thirty-second of an inch wide, which will permit estimation of eighths of a unit by interpolation.

#### CRUSHING TEST

In testing the tenderness of peas, for example, one may wish to measure the weight necessary to crush one cotyledon of a peeled pea to one-fourth of its thickness. The pea is peeled, and one cotyledon is placed with the flat surface in contact with the glass slide. The plunger is then lowered until the disk just touches the pea. The reflection of the pea in the polished lower surface of the disk can be used to determine the precise point of contact. The plunger is held in this position by means of a set screw in its sleeve. The lever is then moved down the scale until its short arm touches the bottom of the platform, as indicated by the sounding of the buzzer. This point on the scale represents the thickness of the half pea. The pointer is then brought back along the scale to one-fourth of this figure. The set screw is released, and the plunger is forced down by adding mercury, at a uniform rate, to the flask, and the pea is slowly crushed. When contact has been made again between the platform and the contact point, the buzzer sounds, indicating that the cotyledon has been crushed to one-fourth of its thickness. The mercury is simultaneously turned off. The weight required for the crushing is that of the flask and mercury plus the weight of the plunger.

In using the instrument for making crushing tests, it is necessary at intervals to see that the zero point is in proper adjustment. To correct the zero reading, the horizontal support (fig. 1, *h*) can be raised or lowered. Provision for this adjustment is made by means of the screw (fig. 1, *k*) controlling a spring slot leading into the

opening where the support fits the upright rod (fig. 1, *i*). To the horizontal support is attached the electrically insulated scale arm (fig. 1, *g*), the pivot of the lever and the arm supporting the sleeve in which the plunger *a* operates. In the examination of samples, it is convenient to use several interchangeable plate-glass slides. All the slides, of course, should be of the same thickness, to obviate the need of adjusting the zero point with each change of slide.

#### PENETRATION TEST

When the tenderness of a canned food such as pears or peaches is to be determined by the penetration method, the lower disk of the plunger is replaced by a cylindrical rod (fig. 2, *r*) five thirty-seconds of an inch in diameter, fastened firmly into the hollow end of the plunger rod by means of a set screw. The rod is placed upon the surface of a section of the fruit, held in an appropriate container,<sup>4</sup> and weight is applied as before. In this case, no measurements of thickness are made, as when sufficient weight has been added perforation is always abrupt and complete.

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<sup>4</sup> A cylinder, approximately  $1\frac{1}{8}$  inches in diameter, made of sheet metal about one-thirty-second of an inch thick, is a convenient container for peaches and pears. With fruit units not thick enough to fit such container, a V-shaped metal trough, 1 inch long, three-fourths inch wide, and three-fourths inch deep, with vertical ends, can be used as a holder.

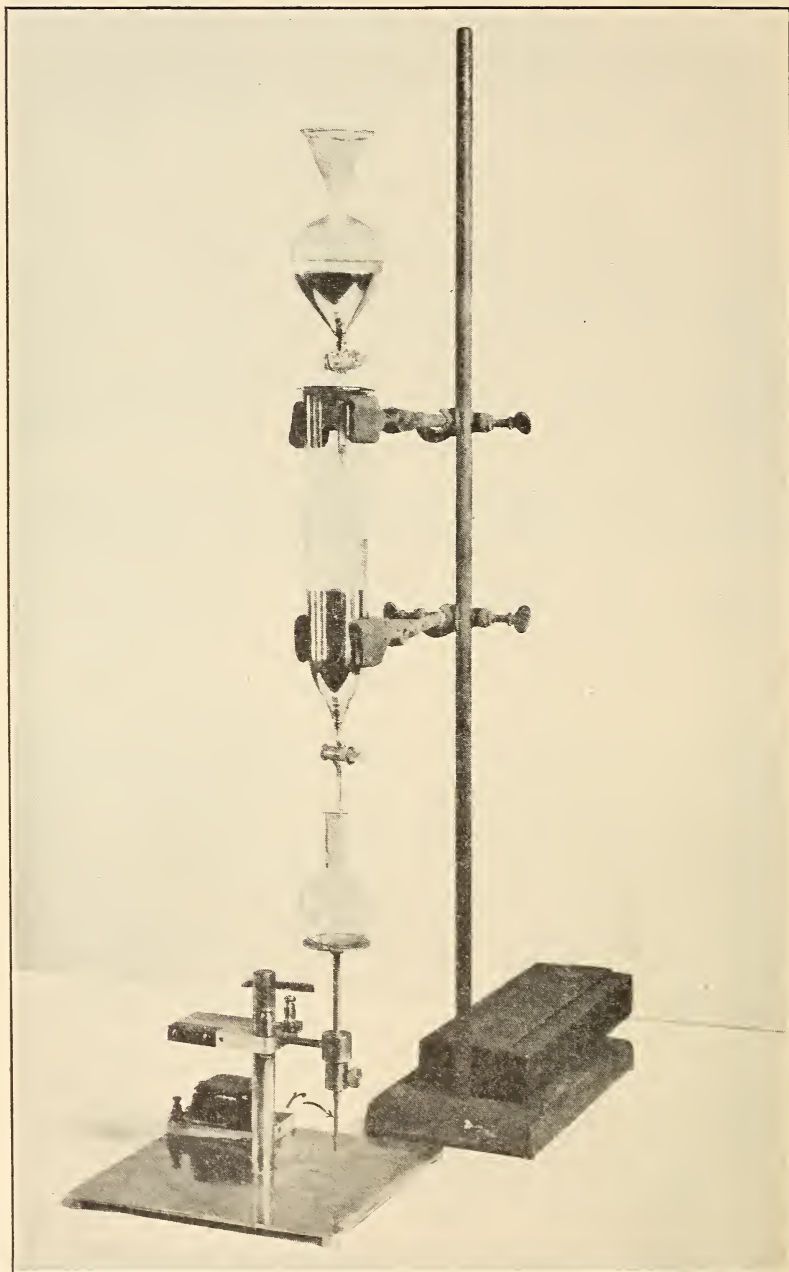


FIGURE 2.—Apparatus for determining tenderness of canned food by penetration

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